H2 Refuel competition draft guidelines

Introduction

Fuel cells powered by hydrogen from renewable or low-carbon resources can lead to substantial energy savings and reductions in imported petroleum and carbon emissions. Fuel Cell Electric Vehicles (FCEVs) are much more efficient than today's gasoline vehicles, and when fueled with hydrogen, produce only water vapor at the tailpipe. The hydrogen fuel can be generated from a range of domestic sources. While the commercial sale of FCEVs is rapidly approaching, infrastructure remains a major challenge, with only approximately 50 stations in the United States and very few operating as public retail stations. As efforts to build a hydrogen fueling station infrastructure are getting underway, the H2 Refuel H-Prize will work to incentivize the development of small-scale systems for non-commercial fueling to supplement the larger-scale infrastructure development.

The Hydrogen Refueler H-Prize anticipates award of a $1 million prize to the top refueler system entry that can produce hydrogen using electricity and/or natural gas, energy sources commonly available to residential locations, and dispense the hydrogen to a vehicle, providing at least 1 kg per refueling. Systems considered would be at the home scale and able to generate and dispense 1-5 kg H_2/day for use at residences, or the medium scale, generating and dispensing 5-50 kg H_2/day. Medium scale systems would serve a larger community with multiple users daily, such as a large apartment complex or retail centers to fuel small fleets of vehicles (e.g., light duty automobiles, forklifts or tractors).

Interested parties can register and find more information, updates and forums where teams and the public can discuss the prize at The H-Prize website: http://hydrogenprize.org. The H-Prize was authorized by the 2007 Energy Independence and Security Act. The Hydrogen Education Foundation (HEF) is administering the prize for the U.S. Department of Energy (DOE), and DOE will coordinate prize activities with HEF.

Summary of H2 Refuel H-Prize plans

The U.S. Department of Energy plans to open the H2 Refuel competition in the Spring of 2014. At that time the final guidelines will be posted in a Federal Register notice and on the H-Prize website (http://hydrogenprize.org), and information can also be found on DOE's Fuel Cell Technologies Office (FCTO) website (http://www1.eere.energy.gov/hydrogenandfuelcells/). The H-Prize website will be the primary source of information about the prize, and will have an online forum that will enable teams to find partners. More detailed information regarding required forms and data to be submitted will be provided to registered teams through the H-Prize website as the competition progresses.

Teams will have a year to design a system and identify a location where it can be installed and used. Twelve months after the competition opens, teams will be required to complete registration and submit system designs and blue prints, plans for installation, and preliminary data to demonstrate that the system satisfies the minimum criteria (see Criteria section). Teams will also need to provide documented evidence of cooperation from the installation site. Of the teams that meet all the minimum criteria, the

top entries, up to five, will be selected as finalists to enter the testing phase. The selected teams will then have seven months to install, and get their systems up and running. The systems must be compatible with remote monitoring equipment to allow remote monitoring for the testing period. Starting 21 months after the competition opens, the finalist systems will be remotely monitored and tested and approximately two months of data will be collected. At least one on-site visit will be performed to verify data and perform tests that cannot be done remotely. Teams must also provide requested information to a DOE designated entity for independent verification of the cost of the system and the cost of the generated hydrogen. The scoring criteria will be ranked and weighted.

Proposed Timeline

Current tentative date	Activity
March 2014	Draft Guidelines posted for public comment
April 2014	Comment period closes
May 2014 (tentative)	Competition opens H-Prize Website opens, including an online system to facilitate teaming and partnerships Teams design systems, collect data, identify installation location, and registers for the prize ahead of data submission deadline
May 2015	Preliminary data submission deadline Teams will submit data, provide designs and blueprints and information about installation site, to indicate that the system is capable of meeting the base criteria
July 2015	Finalist teams are announced – go to testing stage Finalist Teams install systems and get them up and running Before the testing period begins, remote monitoring equipment will be installed by the designated data analysis team
March 2016	System testing begins
May 2016	Competition ends – data is analyzed to determine winner
June 2016 (tentative)	Anticipated winner announcement

Prize criteria and testing

Finalist selection phase

At 12 months, teams interested in competing must register for the competition and submit all required information. To be considered, an entry must meet the initial selection criteria defined below. Teams will be required to submit data that demonstrates the system's ability to meet the indicated criteria. The top teams to provide convincing evidence that the entry could satisfy the minimum criteria will be selected for testing. Specific instructions will be posted on the H-Prize website detailing the required information. In addition to the required technical criteria data, teams will submit system descriptions and designs which will be evaluated by an expert panel to determine that the entries are likely to meet reasonable safety, cost and usability criteria. Usability refers to the ability of the system to be installed and used at the intended locations (e.g., considering footprint and noise), and to be easily operated by the average user (e.g., with minimum training and time). Because a goal of the H-Prize is to advance commercial applications of hydrogen energy technologies, the potential of the systems to ultimately be commercialized will also be evaluated, and a description of a pathway to commercial production of the systems, including manufacturing, will be requested.

Minimum/Maximum Criteria Table

Criteria	Home	Community
Minimum dispensing pressure	350 bar	
Maximum 1 kg dispensing time	10 hours	60 minutes
Min. hydrogen dispensed	1 kg/day	5 kg/day
Hydrogen purity	Meets SAE J2719	
Fill method	Compliant with relevant codes (SAE J2601 for automobiles) and ensures that delivered hydrogen does not exceed the pressure and temperature limits of the vehicle storage tank.	
Safety	Meets relevant safety standards for installation in target location	

Finalist competition

The finalist teams will have seven months to install their systems at a location of their choosing before testing begins. Each entry will be scored in six different technical and cost criteria:

- Dispensing pressure
- 1 kg dispensing time
- Potential 1 kg fills per day
- Tested availability
- Total Installed System cost
- Direct user cost per kg

The criteria and scoring ranges are listed in more detail below.

Testing for the technical criteria will be performed remotely over a period of 2 to 3 months, with at least one on-site inspection to verify data and perform testing that cannot be done remotely. Summary level testing results will be published. The base criteria listed in Minimum/Maximum Criteria Table will be tested to ensure that all entries meet those requirements.

The cost criteria will be evaluated by an independent auditing entity. Teams will be required to submit cost information, such as the bill of materials for the system installation and system operating costs during the testing period. Specific details on required information will be provided to finalist teams after selection.

Entries will receive scores for the tested criteria as described below, with different multipliers for each of the criteria. When testing is complete, the data will be analyzed to determine scores. Once all results have been analyzed, judges will evaluate the results and determine the scores based on the published scoring criteria, and confirm entry eligibility based on the base criteria and eligibility requirements. After resolving any ties (see tie resolution process below), the eligible team with the highest score will be the winner.

Installation site criteria

Any site in the United States can be used for the installation of the refueler, as long as there is access for installing equipment for remote monitoring, for at least one on-site visit for in-depth testing, and at least one visit by the press and public.

To meet testing requirements, the fueling system should be used at an average of at least 50% planned capacity per week (e.g., for a home system designed to dispense 1 kg/day, at least four 1-kg "fills" per week; for a community system designed to produce 20 kg/day, it should dispense at least 70 1-kg "fills" per week). If on-site use is below this level, simulated fills can be used for testing. Simulated fill protocols will be posted on the H-Prize website before testing begins.

Entries must meet the safety codes and standards in effect at the installation location. Teams are encouraged to consider the relevant SAE, ASME and NFPA codes and standards.[1]

Prize criteria

Dispensing Pressure		
Score	**Home**	**Community**
1	350 bar or higher	
2	400 bar or higher	
3	500 bar or higher	
4	600 bar or higher	
5	700 bar or higher (ultimate goal)	

Dispensing Pressure refers to the pressure of the hydrogen dispensed to the vehicle. Intermediate pressures are listed to incentivize advancements towards low-cost systems that can meet the ultimate target of 700 bar.

1 kg dispensing time		
Score	**Home**	**Community**
1	10 hours or less	60 minutes or less
2	8 hours or less	30 minutes or less
3	5 hours or less	15 minutes or less
4	2 hours or less	10 minutes or less
5	30 minutes or less	3 minutes or less

The time required to dispense 1 kg of hydrogen to a vehicle, including time required to connect the system to the vehicle and begin the hydrogen flow. Home systems may have longer fueling times, up to overnight, while multi-user system are expected to have shorter fueling times.

[1] Codes and standards to consider include but are not limited to SAE J2719, ASME B31-12, ASME B31-3, ASME BPV Code, NFPA 2 and NFPA 70. Depending on the system, some codes and standards may not apply.

Potential 1 kg refuelings per day		
Score	**Home**	**Community**
1	1 or more	5 or more
2	2 or more	10 or more
3	3 or more	20 or more
4	4 or more	40 or more
5	5 or more	50 or more

Potential 1-kg fills per day will be based on the highest number of actual or simulated fills completed in a 24 hour period.

Tested Availability	
Score	**Home Community**
1	80% or higher
2	85% or higher
3	90% or higher
4	95% or higher
5	98% or higher

Availability will be tested over a period of two to three months, during which time system usage will need to be at least 50% of the planned capacity per week. Any time spent on repairs or non-routine maintenance during the testing period will count as non-available, even if compensated for (e.g., repairs done during scheduled down-time, or using stored hydrogen).

Total Installed System Cost (capital + installation)		
Score	**Home**	**Community**
1	$25k/kg or less	$15k/kg or less
2	$20k/kg or less	$12.5k/kg or less
3	$15k/kg or less	$10k/kg or less
4	$10k/kg or less	$7.5k/kg or less
5	$5k/kg or less	$5k/kg or less

Total Installed System Costs will be based on the actual cost for the system equipment (including balance of plant to the nozzle interface) as well as the actual installation costs. The total cost for scoring will be based on the amount of hydrogen dispensed per day – for example, a home system designed to dispense 1 kg/day with a system installed cost of $24,000 would score 1 point, while a system designed to dispense 2 kg/day at the same cost would receive a score of 3. Teams will be expected to provide information such as the bill of materials for all components. Details of the specific information requested will be provided to the teams selected for testing. If the system proposed provides heat and/or power in addition to hydrogen for refueling, the cost of the entire system will be considered when scoring this criterion. However, a bonus score of up to 3 points will be awarded for integrated systems in order to offset the additional costs associated with adding heat and/or power, based on how much heat or power is provided.

Direct user cost per kg		
Score	**Home**	**Community**
1	$20 or less	
2	$17 or less	
3	$14 or less	
4	$11 or less	
5	$8 or less	

Direct user cost per kg will be based on feedstock inputs and actual operations and maintenance costs during the testing period, divided by the amount of hydrogen that is produced and used. The direct user cost per kg excludes the capital and installation costs, which are included in the total installed system cost category. Feedstock cost inputs will be based on actual usage, using a single price for all entries for each input to eliminate regional variation, based on the EIA 2014 projections for average price to all users: $0.098/kWh for electricity and $6.60/million BTU for natural gas. All generated and used hydrogen is counted in determining the $/kg – for example, a system that generates 10 kg/day, where 4 kg is used for fuel vehicles and 5 is used in a fuel cell to produce power would divide the daily user costs by 9.

Scoring

Criteria Category	Score multiplier
Dispensing pressure	3
1 kg dispensing time	2
Potential 1-kg refuelings per day	1
Tested Availability	2
System installation cost	2
Direct user cost per kg	1

The criteria were developed through discussion with experts in the field including members of HTAC, other DOE offices, and federal agencies, and from responses to a Request for Information. DOE invites public comment on these criteria. E-mail *H-Prize@go.doe.gov* by April 21, 2014 [Update: deadline has been extended to April 28, 2014].

Each of the criteria are assigned a 1-5 point scale connected to different ranges. To be eligible, entries must receive at least the minimum score for each category. For some criteria, the ranges for home and community systems may be different. A score multiplying factor will be used to weigh the different criteria.

Bonus points	
Points	**Heat or water supply**
1	Supply at least 35 gallons of hot water per day
1	Supply at least 25,000 BTU/hr of space heating
1	Supply at least 10 kWh electricity per day

Scoring examples (Home System)

Example A: Makes all the lowest scores

Criteria Category	Result	Category Score	Score multiplier	Total scores
Dispensing pressure	360 bar	1	3	3
1 kg dispensing time	8 hours	1	2	2
Possible 1-kg refuelings per day	1	1	1	1
Tested Availability	81%	1	2	2
System installation cost	$23k/kg	1	2	2
Direct user cost per kg	$19/kg	1	1	1
Bonus categories	None	0	0	0
Total	--	--	--	11

Example B: Mixture of scoring levels

Criteria Category	Result	Category Score	Score multiplier	Total scores
Dispensing pressure	475 bar	2	3	6
1 kg dispensing time	3 hours	3	2	6
Possible 1-kg refuelings per day	3	3	1	3
Tested Availability	88%	2	2	4
System installation cost	$18k/kg	2	2	4
Direct user cost per kg	$11/kg	4	1	4
Bonus categories	Supplies hot water	1	--	1
Total	--	--	--	28

Judging and testing

A panel of independent judges will be assembled from experts in relevant fields, selected by DOE in consultation with HEF. Judges may be selected from organizations such as the Hydrogen Safety Panel, the Hydrogen and Fuel Cells Technical Advisory Committee, National Labs, and relevant federal agencies. An independent testing entity will be selected to perform remote and on-site technical data collection, and an independent auditing oversight entity will collect and analyze the cost data.

Tie resolution process

If the results for any of the technical criteria for different entries differ by less than the measurement error range, then those systems will be considered tied for that category and given the higher of the two scores (for example, if the pressure measurement error range is 5%, and Entry A has a dispensing pressure of 499 bar and Entry B has a pressure of 500 bar, both will be given 3 points for the category).

If the top entries' total scores are tied, the entry with the highest measured pressure will win; if the pressure measurements are within the measurement error, the entry with the highest measured availability will be selected as the winner. Otherwise, the entry with the highest score will win.

Competition requirements and process

Eligibility

This H-Prize Competition is open to participants, defined as individuals, entities, or teams that meet the following requirements:

1. Comply with all Registration and H-Prize Competition Rules and Requirements;
2. In the case of a private entity: be organized or incorporated in the United States, and maintain for the duration of the H-Prize Competition a primary place of business in the United States;
3. In the case of all individuals (whether participating singly or as part of an entity or team): be a citizen of, or an alien lawfully admitted for permanent residence into, the United States as of the date of Registration in the H-Prize Competition and maintain that status for the duration of the H-Prize Competition;
4. In the case of U.S. Citizens: provide proof of U.S. Citizenship with Registration, as follows:
    a. Notarized copy of U.S. Passport, or
    b. Notarized copies of both a current U.S. driver's license issued from one of the 50 States or a U.S. Territory and a birth certificate;
5. In the case of aliens lawfully admitted for permanent residence in the United States: Provide notarized copy of Permanent Resident Card (Form 1-551)(green card) with Registration;
6. In the case of entities: Provide a copy of the entity formation documentation (e.g. Articles of Incorporation) showing the place of formation, as well as a self-certification of the primary place of business;
7. The participant, or any member of a participant, shall not be a Federal entity, a Federal employee acting within the scope of his or her employment, or an employee of a National Laboratory acting within the scope of his or her employment;
8. Sign a waiver of claims against the Federal Government and the HEF. *See* 42 U.S.C. § 16396(f)(5)(A);
9. Obtain liability insurance, or satisfactorily demonstrate financial responsibility, during the period of the H-Prize Competition. 42 U.S.C. § 16396(f)(5)(B)(i);
10. Name the Federal Government as an additional insured under the Registered participants' insurance policy and agree to indemnify the Federal Government against third party claims. 42 U.S.C. § 16396(f)(5)(B)(ii);
11. Teams and Entities:
    a. Each team or entity will designate a team leader who will be the sole point of contact with H-Prize Competition officials;
    b. Team or entity members will be identified at the time of Registration on the team roster. Members participating on multiple teams will be required to disclose participation to each team;
    c. Changes to team rosters will be allowed up to 72 hours prior to the award presentation, provided citizenship and immigration requirements are met;

Registration process

After announcement in the Federal Register, registration and all required eligibility documentation must be completed through the web site http://hydrogenprize.org no later than one week before the initial data submission deadline. Early registration is encouraged.

H-Prize Competition Schedule

Once registered, teams will receive all notices and rules updates, including answers to questions asked by the participants. The public web site, http://hydrogenprize.org, will also post this same information, including publicity about various teams and sponsors. Participants are encouraged to utilize the web site as a means of highlighting any information they would like to convey to the public or potential sponsors. There are no entry fees.

At the end of 12 months, on or about May 2015, participants will be required to submit initial data (including information on how the data was gathered and measured) and requested financial information for evaluation by a designated panel of judges. Instructions for the initial data submission will be posted on the web site and sent electronically to the designated contact person for each participant.

Testing and evaluations are planned to be completed in May 2016. The winner determined after all testing data has been analyzed to determine scoring and any ties resolved as described above. DOE plans select and announce a winner within three months after the close of the competition.

Intellectual property

Intellectual property rights developed by the participant for H-Prize technology are set forth in Section 654 of P.L. 110-140 (http://www.gpo.gov/fdsys/pkg/STATUTE-121/html/STATUTE-121-Pg1492.htm). No parties managing the contest, including the U.S. Government, their testing laboratories, judges or H-Prize administrators will claim rights to the intellectual property derived by a registered participant as a consequence of, or in direct relation to, their participation in this H-Prize Competition. The Government and the participant may negotiate a license for the Government to use the intellectual property developed by the participant.

Cancellation and team disqualification

A participant may be disqualified for the following reasons:

- At the request of the registered individual or team leader;
- Failure to meet or maintain eligibility requirements (note that at the time of the prize award, if it is determined that a contestant has not met or maintained all eligibility requirements, they shall be disqualified without regard to H-Prize Competition performance);
- Failure to submit required documents or materials on time;
- Fraudulent acts, statements or misrepresentations involving any H-Prize participation or documentation; or,

- Violation of any federal, state or local law or regulation inconsistent with the H-Prize Competition.

DOE reserves the right to cancel this prize program at any time prior to the completion of system testing.

Liability and competition costs

The Department of Energy, H-Prize, the Hydrogen Education Foundation and any sponsoring or supporting organization assume no liability or responsibility for accidents or injury related to the Prize.

The entrants are responsible for costs associated with participating in the competition including but not limited to designing, installing and operating their systems.